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AIR FORCE RESEARCH LABORATORY

Human Performance Modeling Presentation/Brief

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Interim Report for October 1998 to November 2005

Human Effectiveness Directorate
Warfighter Interface Division
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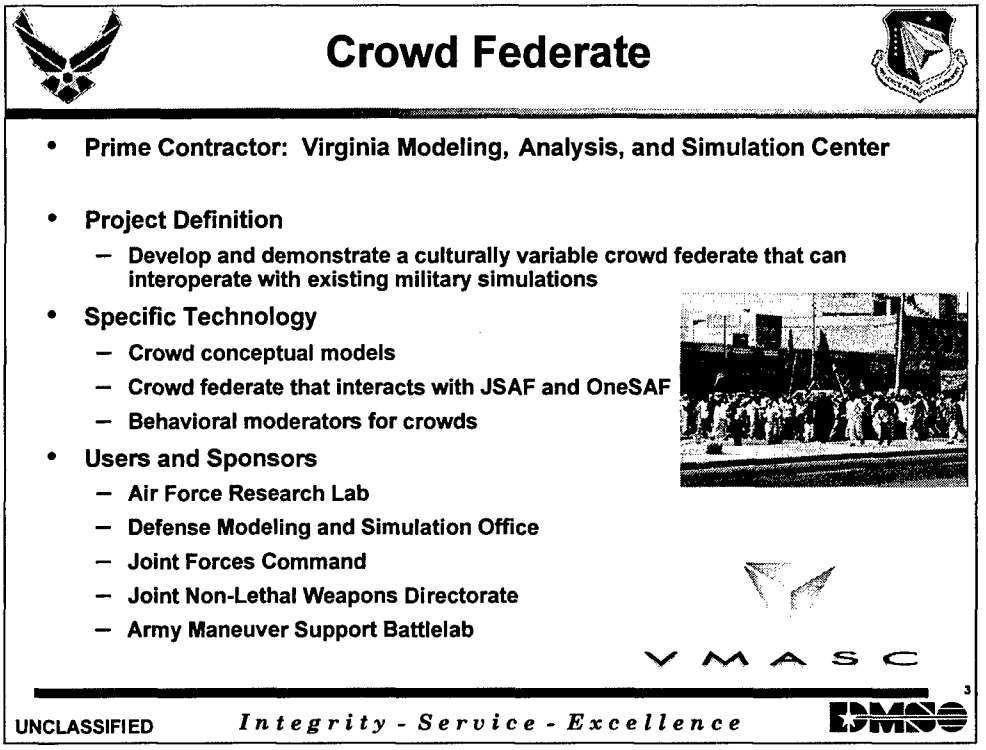
Introduction

- **AFRL manages the Defense Modeling and Simulation Office (DMSO) Human Performance program**
- **Today I will provide an overview of:**
  - **Crowd modeling**
  - **Rules of engagement simulation**
  - **Non-lethal weapons modeling**
  - **Cultural modeling testbed**
  - **Recently transition projects**

These are the topics I will be covering today:

Crowd modeling
Rules of engagement simulation
Non-lethal weapons modeling
Cultural modeling testbed
Recently transition projects



The Prime contractor is VMASC

The goal of the effort is to:

Develop and demonstrate a culturally variable crowd federate that can interoperate with existing military simulations

Specific Technology that is being developed includes

Crowd conceptual models

Crowd federate that interacts with JSAF and OneSAF

Behavioral moderators for crowds

Users and Sponsors

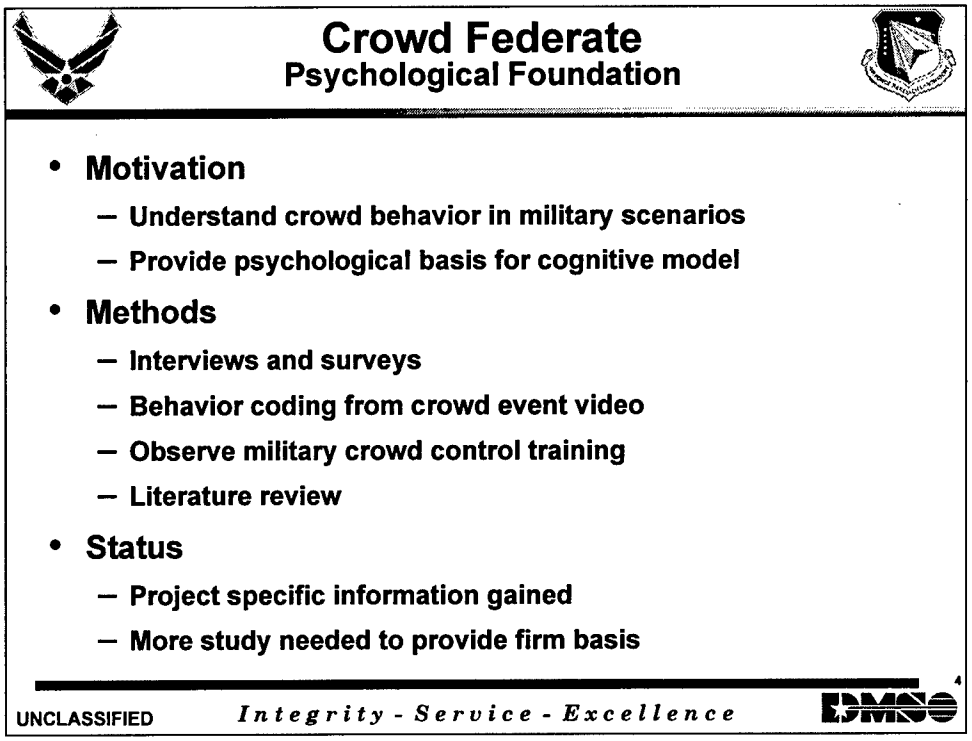
Air Force Research Lab

Defense Modeling and Simulation Office

Joint Forces Command

Joint Non-Lethal Weapons Directorate

Army Maneuver Support Battlelab



The Motivation of the effort was to:

Understand crowd behavior in military scenarios

Provide psychological basis for cognitive model

Methods that were employed include

Interviews and surveys

Behavior coding from crowd event video

Observe military crowd control training

Literature review

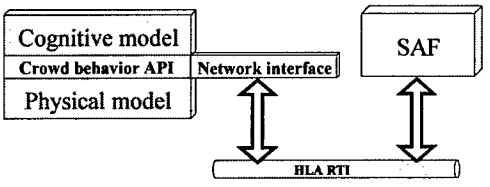
Status

Project specific information gained

More study needed to provide firm basis

Crowd Federate Architecture

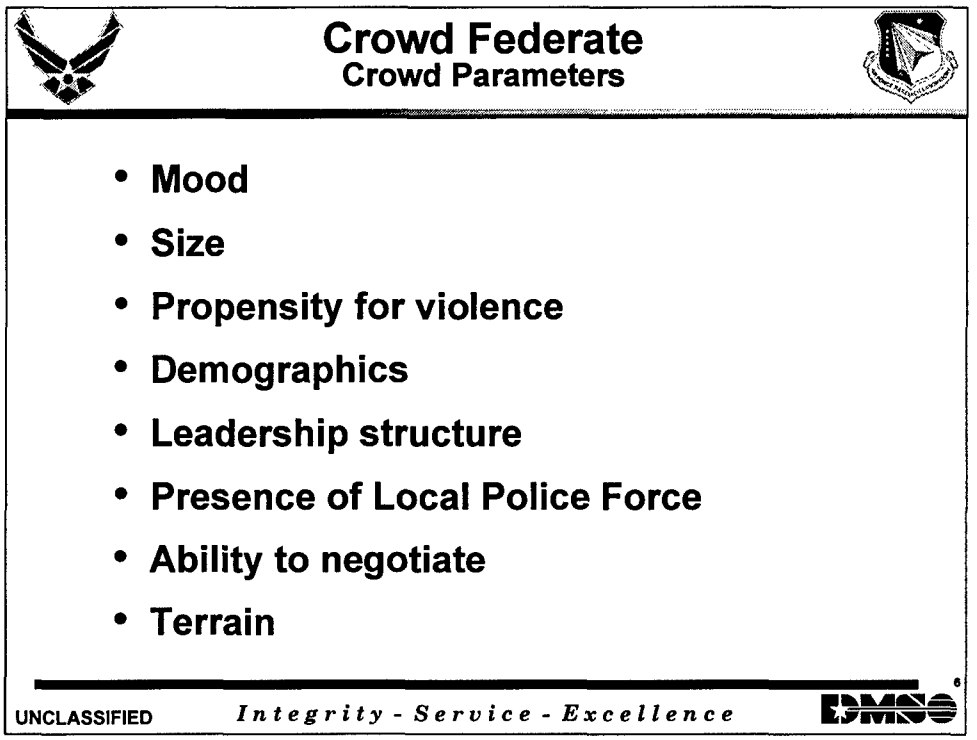
- **Modular architecture**
  - **Cognitive model**
  - **Crowd behavior API**
  - **Physical model**
  - **Network interface**



- **Software**
  - **Programmed in C++**
  - **Uses some commercial software components**

A key product of the effort was a modular architecture that allows different models to be incorporated into a simulation

The software was programmed in C++



Some of the parameters that were modeled include:

Mood

Size

Propensity for violence

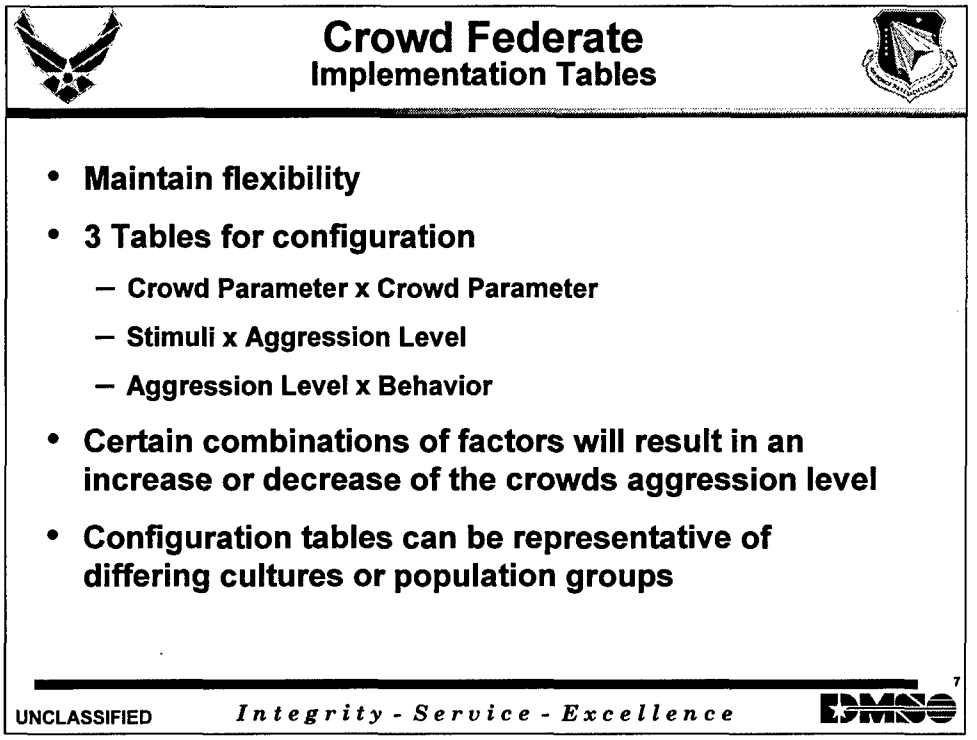
Demographics

Leadership structure

Presence of Local Police Force

Ability to negotiate

Terrain



The behavior is controlled through implementation tables, of which there are three:

3 Tables for configuration

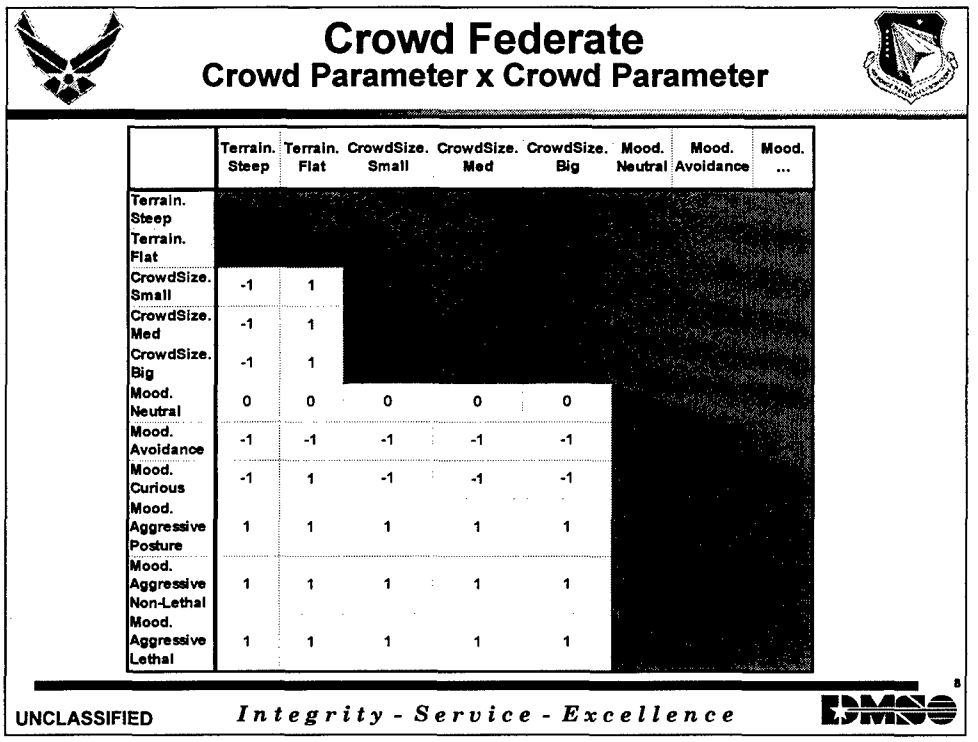
Crowd Parameter x Crowd Parameter

Stimuli x Aggression Level

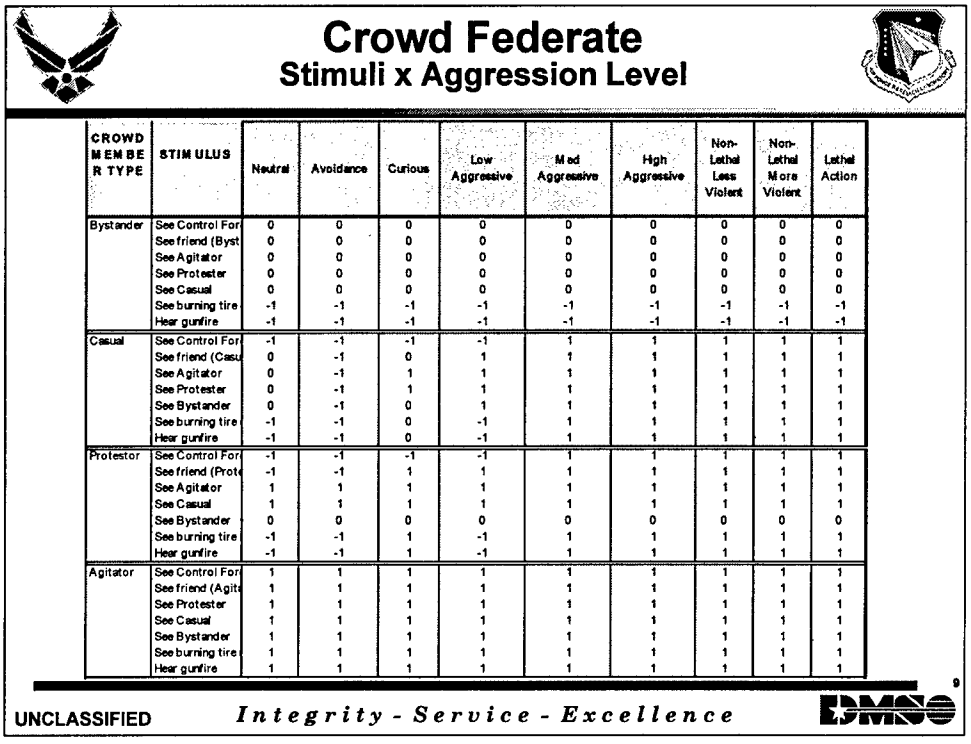
Aggression Level x Behavior

Certain combinations of factors will result in an increase or decrease of the crowds aggression level

Configuration tables can be representative of differing cultures or population groups



Here is the first table.



Crowd Federate
Stimuli x Aggression Level

CROWD MEMBER TYPE	STIMULUS	Neutral	Avoidance	Curious	Low Aggressive	Med Aggressive	High Aggressive	Non-Lethal Less Violent	Non-Lethal More Violent	Lethal Action
Bystander	See Control For	0	0	0	0	0	0	0	0	0
	See friend (Byst	0	0	0	0	0	0	0	0	0
	See Agitator	0	0	0	0	0	0	0	0	0
	See Protester	0	0	0	0	0	0	0	0	0
	See Casual	0	0	0	0	0	0	0	0	0
	See burning tire	-1	-1	-1	-1	-1	-1	-1	-1	-1
	Hear gunfire	-1	-1	-1	-1	-1	-1	-1	-1	-1
Casual	See Control For	-1	-1	-1	-1	1	1	1	1	1
	See friend (Casu	0	-1	0	1	1	1	1	1	1
	See Agitator	0	-1	1	1	1	1	1	1	1
	See Protester	0	-1	1	1	1	1	1	1	1
	See Bystander	0	-1	0	1	1	1	1	1	1
	See burning tire	-1	-1	0	-1	1	1	1	1	1
	Hear gunfire	-1	-1	0	-1	1	1	1	1	1
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	See friend (Prot	-1	-1	1	1	1	1	1	1	1
	See Agitator	1	1	1	1	1	1	1	1	1
	See Casual	1	1	1	1	1	1	1	1	1
	See Bystander	0	0	0	0	0	0	0	0	0
	See burning tire	-1	-1	1	-1	1	1	1	1	1
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	See Protester	1	1	1	1	1	1	1	1	1
	See Casual	1	1	1	1	1	1	1	1	1
	See Bystander	1	1	1	1	1	1	1	1	1
	See burning tire	1	1	1	1	1	1	1	1	1
	Hear gunfire	1	1	1	1	1	1	1	1	1

Table two.

Crowd Federate
Aggression Level x Behavior (1 of 2)

Aggression Level	Behavior	Agitator	Protestor	Casual	Bystander
Avoidance	Fleeing from	20	20	25	27
	Crowd retreating	20	17	20	22
	Hiding	10	25	10	0
	Scattering	30	25	20	22
	Dispersing	30	18	25	29
Neutral	Standing around individually	40	60	40	50
	Observers not participating	60	40	60	50
Curious	Hanging out/watching	0	20	20	40
	Climbing elevated structures	0	40	20	10
	Wandering	0	20	40	10
	Staring at	0	20	20	40
LowAggressive	Flagwaving	20	30	40	0
	Standing on elevated structure	20	30	40	0
	Seeking to	40	30	20	0
	Carrying weapon on shoulder	20	10	0	0
MedAggressive	Chanting	25	30	36	0
	Waving signs and banners	18	17	23	0
	Seeking to	13	12	12	0
	Overturning dumpsters	13	12	12	0
	Carrying weapon in-hand	18	12	0	0
	Marching	13	17	17	0

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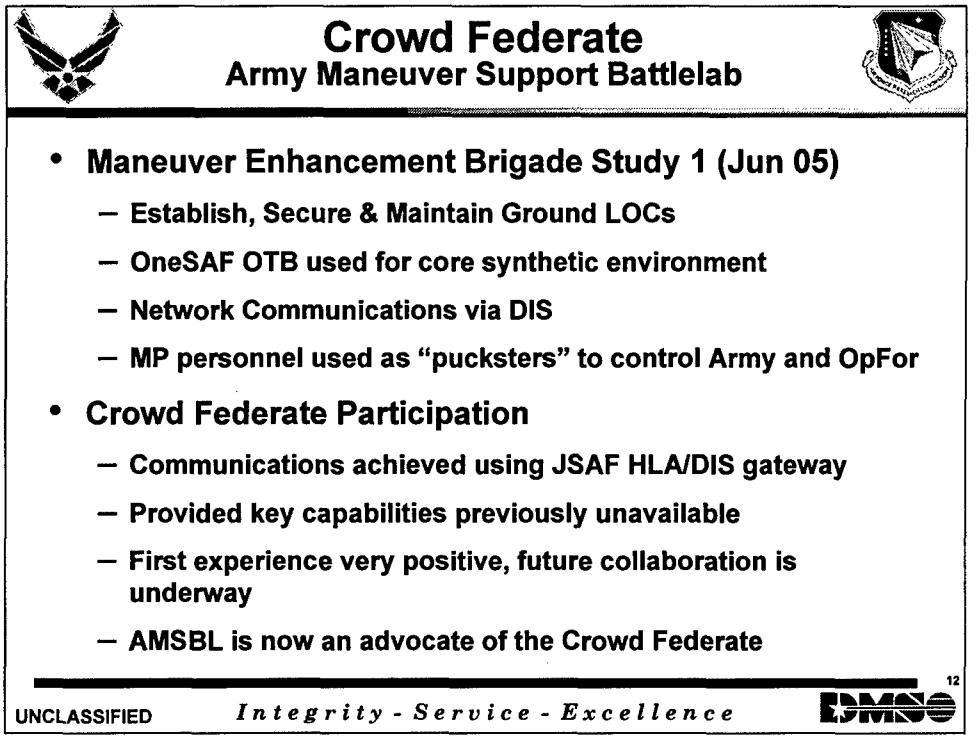
Table three.

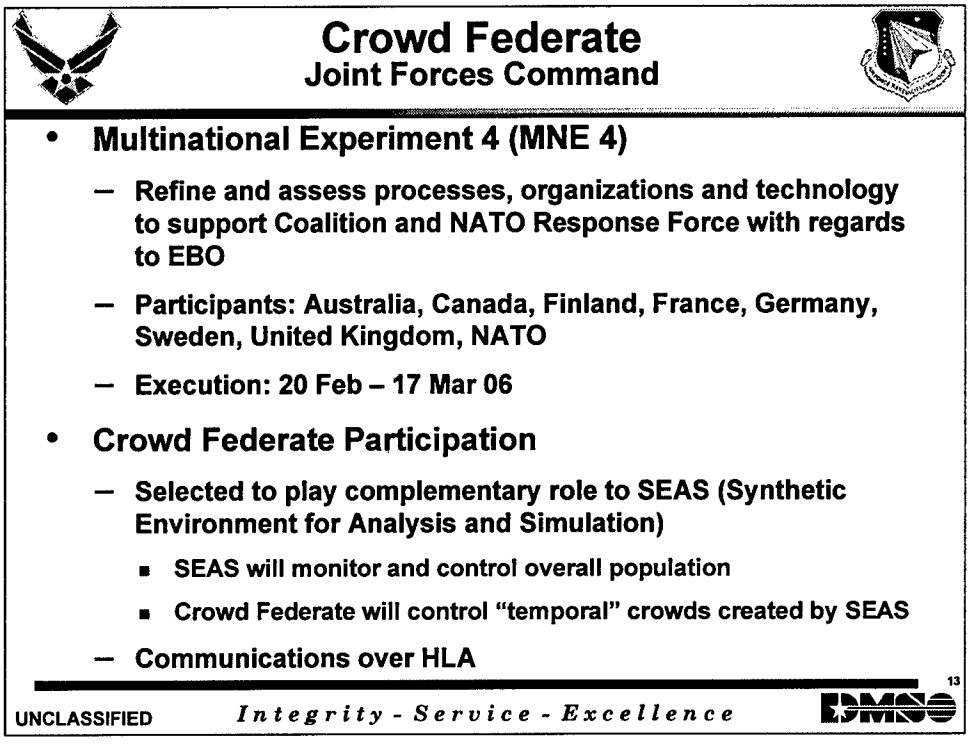
Crowd Federate
Aggression Level x Behavior (2 of 2)

Aggression Level	Behavior	Agitator	Protestor	Casual	Bystander
HighAggressive	Cursing/yelling	15	16	17	0
	Obscene hand gestures	15	16	17	0
	Swarm to	15	15	15	0
	Looting	15	16	17	0
	Taunting	15	16	17	0
	Brandishing weapon	10	5	0	0
	Picking up projectiles	15	16	17	0
NonLethalLessViolent	Pushing	27	28	30	0
	Punching	27	28	30	0
	Burning objects	19	16	12	0
	Throwing objects	27	28	28	0
NonLethalMoreViolent	Throwing pepper gas cans	30	40	15	0
	Gang beating (fighting)	25	25	35	0
	Looting	25	25	35	0
	Shooting in air	20	10	15	0
LethalAction	Shooting at	40	33	0	0
	Throwing Molotov cocktail	14	15	0	0
	Throwing Grenade	18	22	0	0
	Shooting Technicos gun-mounted pickups	10	10	0	0
	RPG	18	20	0	0

This table depicts some of the interactions between the various factors.



The crowd federate has been demonstrated at the Army Maneuver Support Battle Lab



There are plans to incorporate the crowd federate into a JFCOM exercise. In this exercise it will interact with another simulation.

Crowd Federate
Summary

- **Successes**
  - **Movement from demonstration to participation**
  - **Initial transition underway**
    - **Additional support for the AMBSL planned with FY05 funds**
    - **JFCOM is bringing the Crowd Federate into the ATT**
    - **JFCOM will use the Crowd Federate in upcoming NATO experiment**
- **More work to be done**
  - **Crowd/group & Individual level parameter understanding & validation**
  - **Psychological model refinement**

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In summary...

Movement from demonstration to participation

Initial transition underway

Additional support for the AMBSL planned with FY05 funds

JFCOM is bringing the Crowd Federate into the ATT

JFCOM will use the Crowd Federate in upcoming NATO experiment

More work to be done

Crowd/group & Individual level parameter understanding & validation

Psychological model refinement

Rules of Engagement Evaluation Environment (ROE3)

- **Prime Contractor: Agent Oriented Software**

- **Project Definition**
  - **Create tools for investigating the employment and effects of Rules of Engagement (ROE)**
- **Specific Technology**
  - **Human behavior modeling environment for modeling ROEs**
  - **Framework and software tools for defining ROEs, tactics, behavior models and moderators**
  - **Cognitive architecture that incorporates behavior moderators**
- **Users and Sponsors**
  - **Air Force Research Lab**
  - **Defense Modeling and Simulation Office**

Agent Ori

Project Definition

Create tools for investigating the employment and effects of Rules of Engagement (ROE)

Specific Technology

Human behavior modeling environment for modeling ROEs

Framework and software tools for defining ROEs, tactics, behavior models and moderators

Cognitive architecture that incorporates behavior moderators

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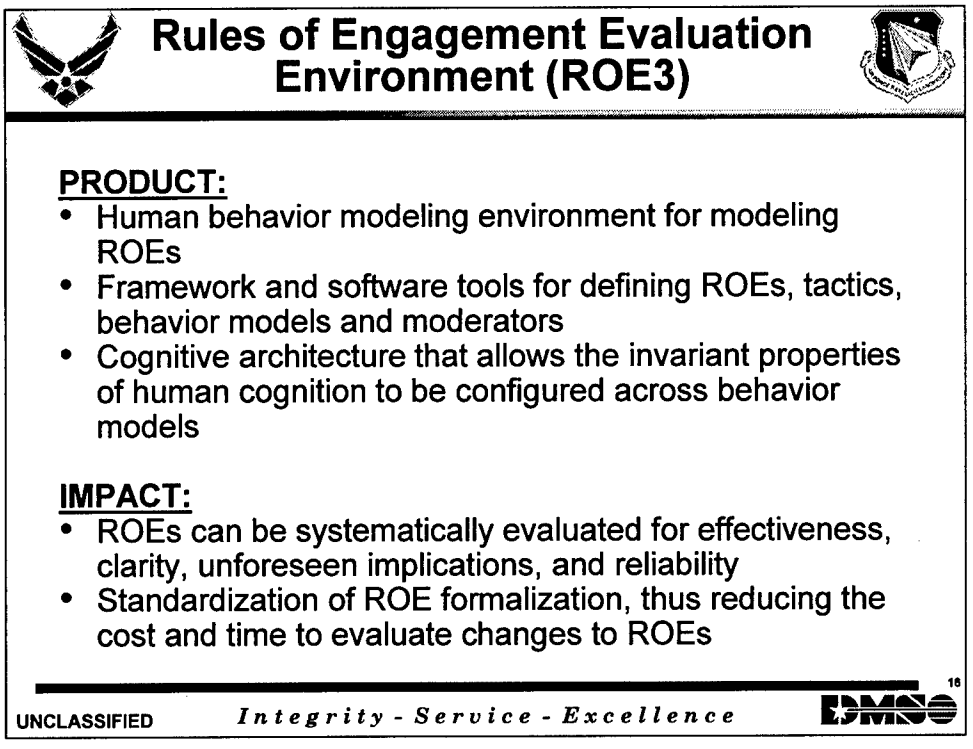
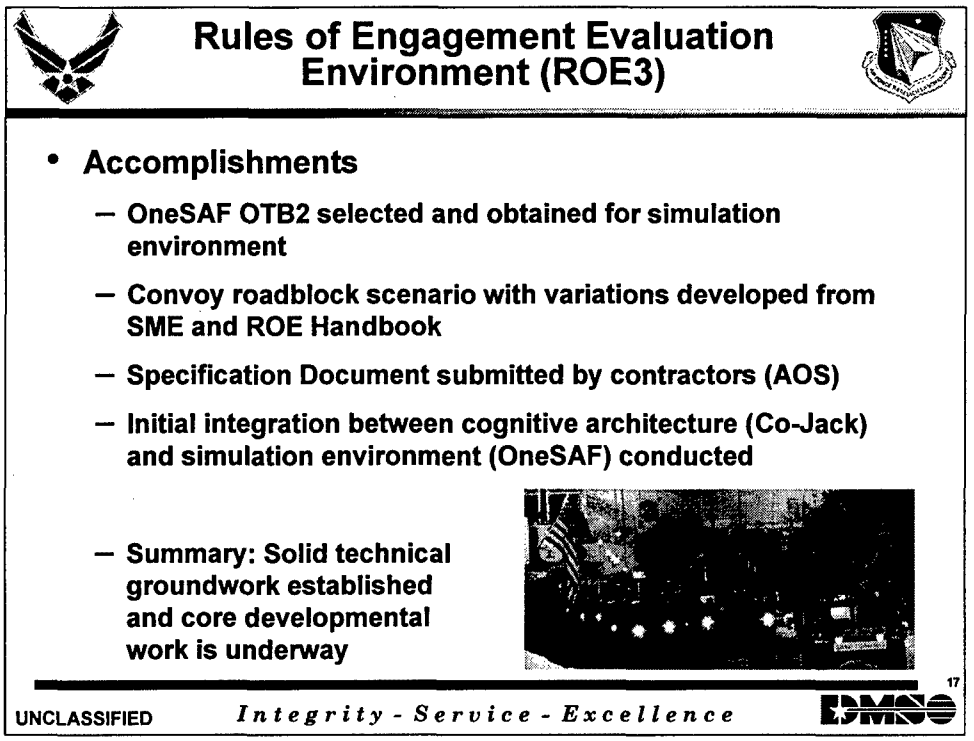


PRODUCT:

Human behavior modeling environment for modeling ROEs
Framework and software tools for defining ROEs, tactics, behavior models and moderators
Cognitive architecture that allows the invariant properties of human cognition to be configured across behavior models

IMPACT:

ROEs can be systematically evaluated for effectiveness, clarity, unforeseen implications, and reliability
Standardization of ROE formalization, thus reducing the cost and time to evaluate changes to ROEs



Accomplishments

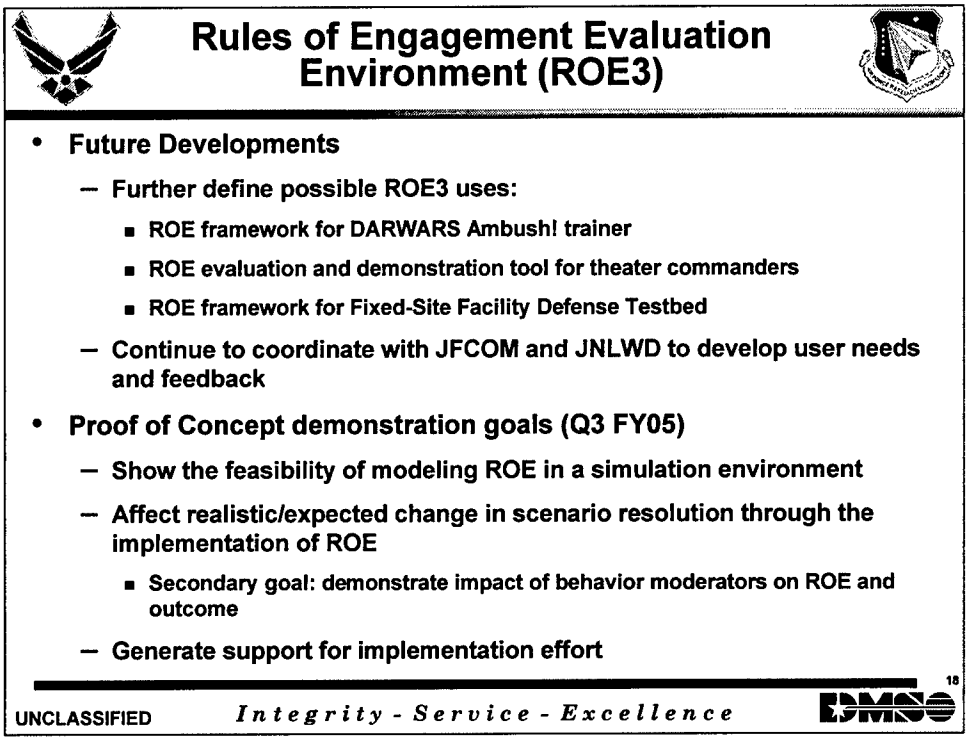
OneSAF OTB2 selected and obtained for simulation environment

Convoy roadblock scenario with variations developed from SME and ROE Handbook

Specification Document submitted by contractors (AOS)

Initial integration between cognitive architecture (Co-Jack) and simulation environment (OneSAF) conducted

Summary: Solid technical groundwork established and core developmental work is underway



Potential future developments include:

- Further define possible ROE3 uses:
  - ROE framework for DARWARS Ambush! trainer
  - ROE evaluation and demonstration tool for theater commanders
  - ROE framework for Fixed-Site Facility Defense Testbed
- Continue to coordinate with JFCOM and JNLWD to develop user needs and feedback

Proof of Concept demonstration goals (Q3 FY05)

- Show the feasibility of modeling ROE in a simulation environment
- Affect realistic/expected change in scenario resolution through the implementation of ROE
  - Secondary goal: demonstrate impact of behavior moderators on ROE and outcome
- Generate support for implementation effort

Rules of Engagement Evaluation Environment (ROE3)

- **Possible implementation actions**
  - **Provide UI control to allow users to test, evaluate, and demonstrate different ROE under various circumstances**
    - **ROE – Provide sets of ROE and a ROE construction tool**
    - **Scenario – Select location and event**
    - **Personnel – Friendly and opposition forces**
  - **Develop knowledge base and library of locations, ROE sets, and scenarios**

Possible implementation actions

Provide UI control to allow users to test, evaluate, and demonstrate different ROE under various circumstances

ROE – Provide sets of ROE and a ROE construction tool

Scenario – Select location and event

Personnel – Friendly and opposition forces

Develop knowledge base
and library of locations,
ROE sets, and scenarios

Non-Lethal Weapon Models

- **Prime Contractor**
  - Micro Analysis & Design
- **Project Definition**
  - Develop Non-Lethal Weapons libraries for use in JSAF and OneSAF

- **Specific Technology**
  - Non-Lethal Weapon libraries in JSAF and OneSAF
- **Users and Sponsors**
  - Air Force Research Lab
  - Defense Modeling and Simulation Office
  - Joint Non-Lethal Weapons Directorate
  - Crowd Federate and ROE3

Micro Analysis & Design

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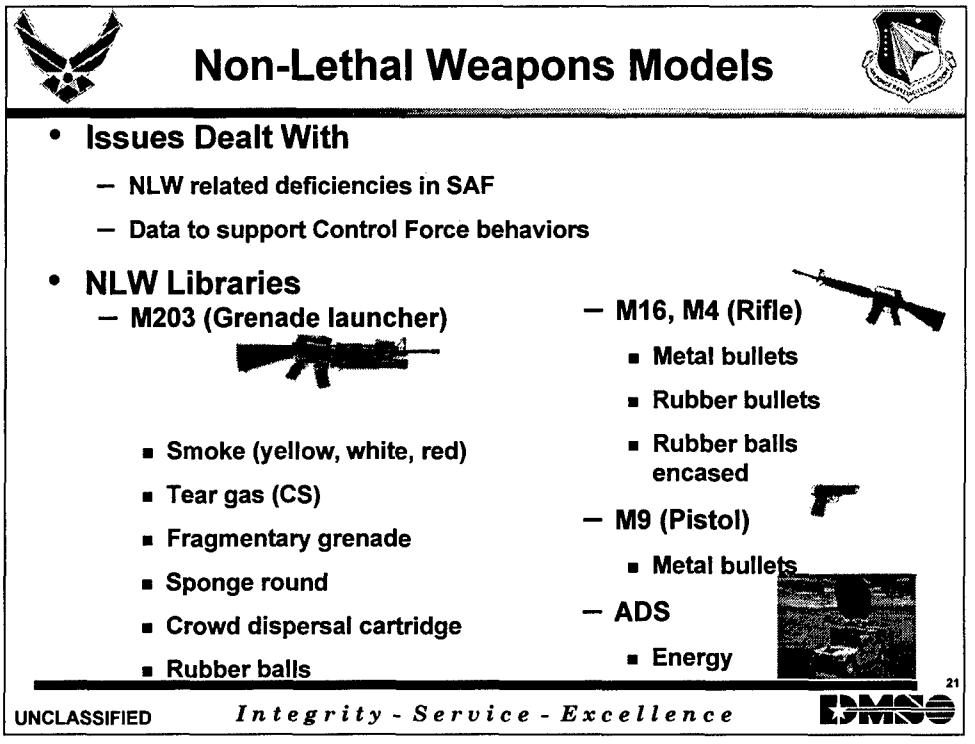
Another completed effort addressed the development of models of non-lethal weapons. Specifically, model libraries were created for JSAF and OneSAF.



Model libraries include:

M203 (Grenade launcher)

Smoke (yellow, white, red)

Tear gas (CS)

Fragmentary grenade

Sponge round

Crowd dispersal cartridge

Rubber balls

Culture and Personality Testbed
Overview

- **Prime Contractor:** BBN Technologies

- **Project Definition**
  - Develop research testbed using commercial game technology, Neverwinter Nights TM, to quantify the role of personality and cultural factors in military operations.
- **Specific Technology**
  - Algorithms and other techniques to represent socio-cultural knowledge
  - Quantitative data on cultural differences in military operations
  - C2 system analysis tools and methods
- **Users and Sponsors**
  - Air Force Research Lab
  - Army Research Lab
  - Defense Modeling and Simulation Office
  - NATO

BBN TECHNOLOGIES

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The Culture and Personality has completed the initial testbed.

Funding received for FY05 and FY06 to further refine the testbed and conduct experiments.

Initial BBN testing will compare Americans and Chinese (Boston area students)

The testbed is receiving a range of interest, test cases planned for NATO and Korea, also several graduate study programs are interested

The problem we are addressing is:

Problem: **Military operations are increasingly multinational involving partner nations with diverse cultures**

Wing Commander & Group Captain

Numbers, commas & decimals: 2.000 = ?

Military requires a better understanding of coalition partners for smoother operations

Culture and Personality Testbed
Vision

- **Vision:** Develop a testbed for culture & personality research based on a commercial game
- **Testbed Advantages**
  - Action/behavior based rather than hypothetical situations or self-reports
    - New paradigm for culture research!
  - Immersive environment:
    - True self can emerge
  - Replicability
  - Easier data collection
    - Decouple researcher & subject
    - Potentially larger subject pool available

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Our goal is to **Develop a testbed for culture & personality research based on a commercial game**

The advantages are:

Action/behavior based rather than hypothetical situations or self-reports

New paradigm for culture research!

Immersive environment:

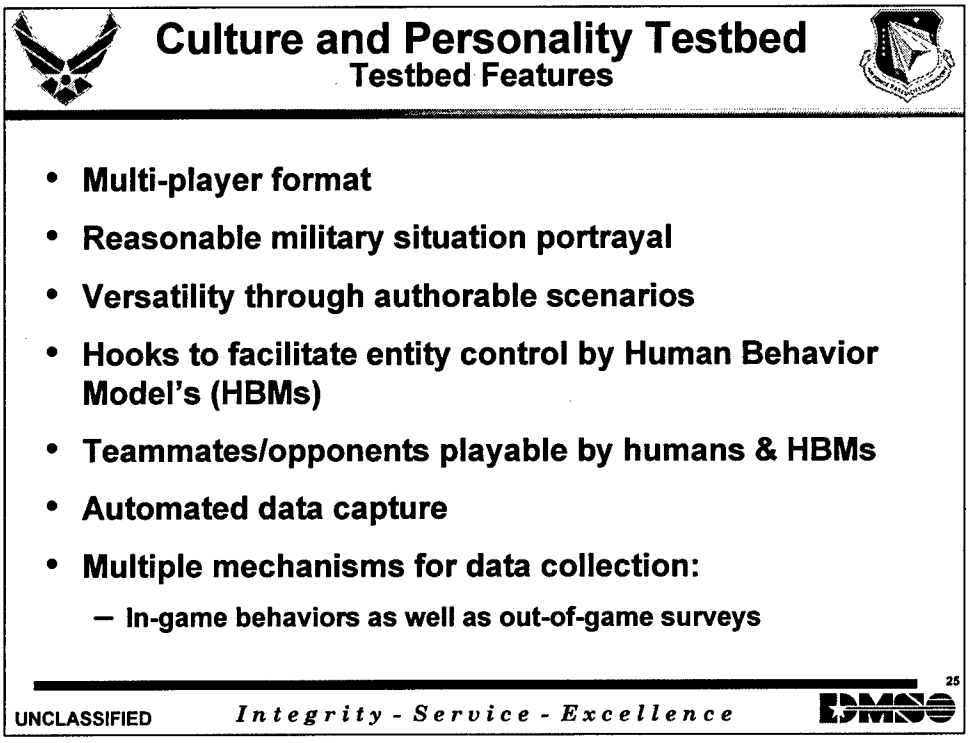
True self can emerge

Replicability

Easier data collection

Decouple researcher & subject

Potentially larger subject pool available



Key features include:

Multi-player format

Reasonable military situation portrayal

Versatility through authorable scenarios

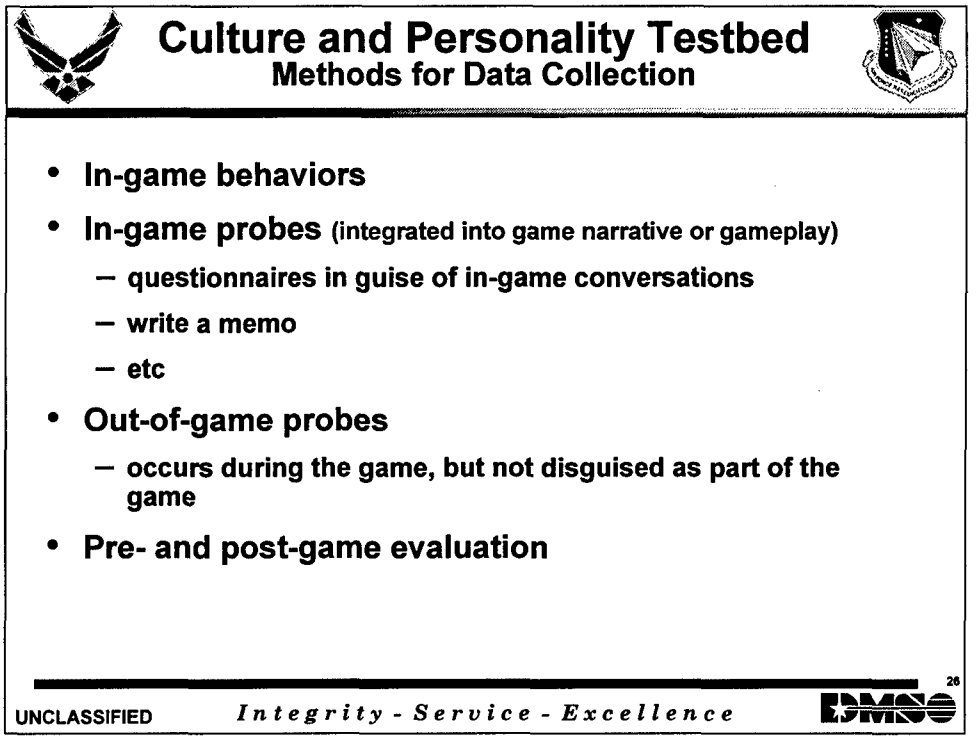
Hooks to facilitate entity control by Human Behavior Model's (HBMs)

Teammates/opponents playable by humans & HBMs

Automated data capture

Multiple mechanisms for data collection:

In-game behaviors as well as out-of-game surveys



Date we can collect include:

In-game behaviors

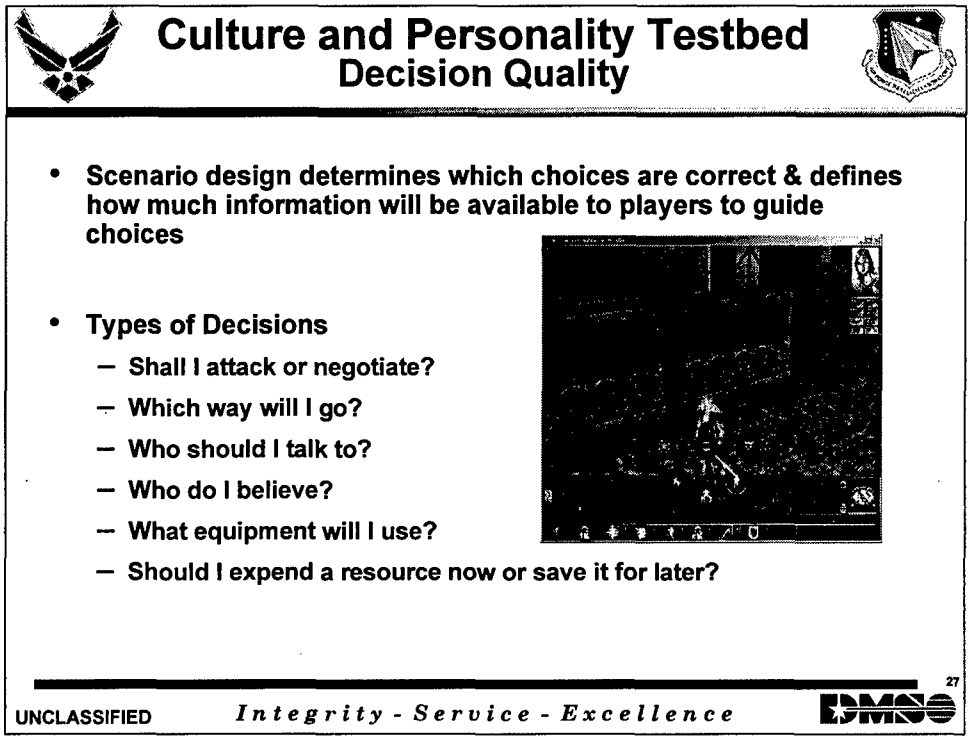
In-game probes (integrated into game narrative or gameplay)

- questionnaires in guise of in-game conversations
- write a memo
- etc

Out-of-game probes

- occurs during the game, but not disguised as part of the game

Pre- and post-game evaluation



The types of decisions the players have to make include:

Shall I attack or negotiate?

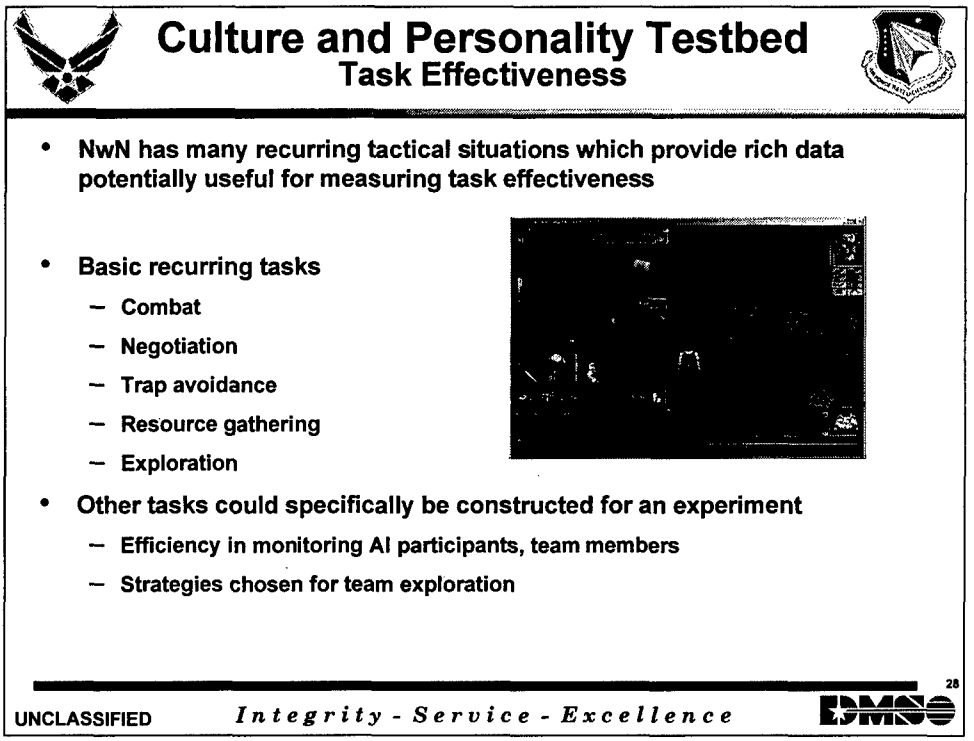
Which way will I go?

Who should I talk to?

Who do I believe?

What equipment will I use?

Should I expend a resource now or save it for later?



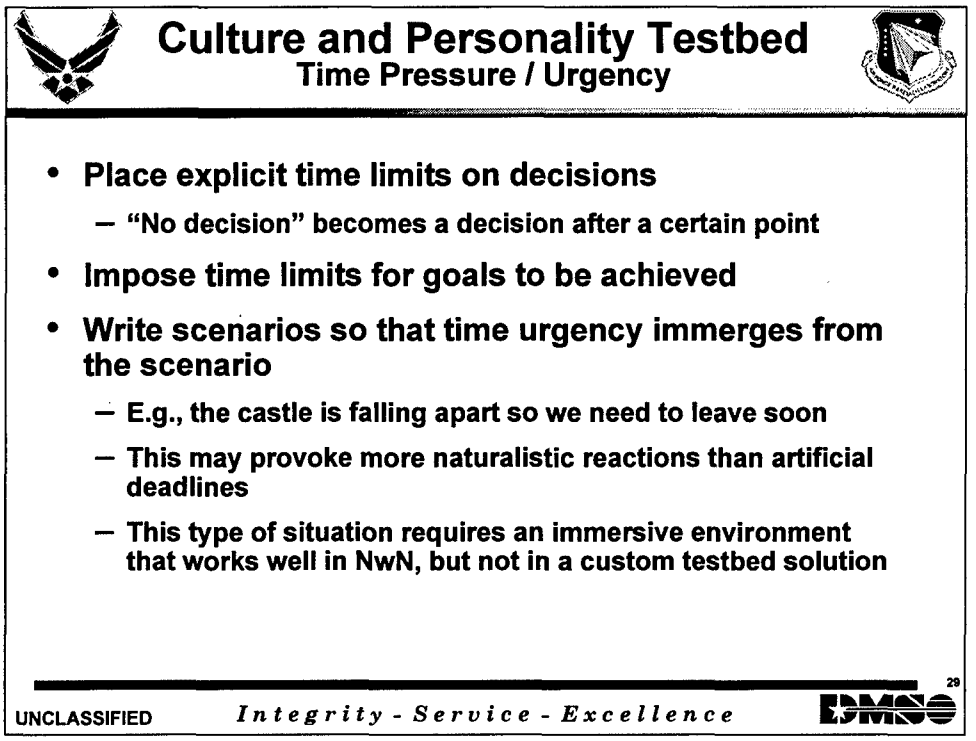
NwN has many recurring tactical situations which provide rich data potentially useful for measuring task effectiveness

Basic recurring tasks

- Combat
- Negotiation
- Trap avoidance
- Resource gathering
- Exploration

Other tasks could specifically be constructed for an experiment

- Efficiency in monitoring AI participants, team members
- Strategies chosen for team exploration



Place explicit time limits on decisions

"No decision" becomes a decision after a certain point

Impose time limits for goals to be achieved

Write scenarios so that time urgency immerges from the scenario

E.g., the castle is falling apart so we need to leave soon

This may provoke more naturalistic reactions than artificial deadlines

This type of situation requires an immersive environment that works well in NwN, but not in a custom testbed solution

Culture and Personality Testbed
How to Measure Decision Making Strategies

- **Set up scenarios with options for**
  - **Spending time gathering information**
  - **Spend time planning**
  - **Jumping directly into the situation**
- **Monitor actions, individual & team**
  - **Negotiation, exploration, combat,**
  - **Resource gathering, etc.**
- **Monitor communication**
  - **How much, who, about, etc**
- **Scenarios can be fairly linear or very open & parallel allowing extensive experimenter control of degree of flexibility given to participants.**

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The way to measure decision-making is to

Set up scenarios with options for

Spending time gathering information

Spend time planning

Jumping directly into the situation

Monitor actions, individual & team

Negotiation, exploration, combat,

Resource gathering, etc.

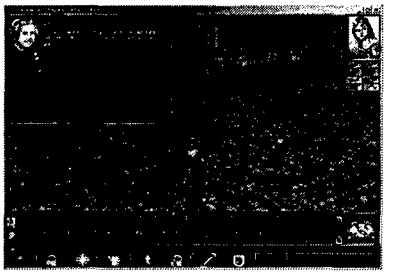
Monitor communication

How much, who, about, etc

Scenarios can be fairly linear or very open & parallel allowing extensive experimenter control of degree of flexibility given to participants.

Culture and Personality Testbed
How to Measure Communication Patterns

- **Communication mechanisms provided in game**
- **NwN virtual world constrains communication: only avatars in same virtual room can communicate**
- **Communication difficulty can be manipulated using these constraints**



Communication mechanisms provided in game

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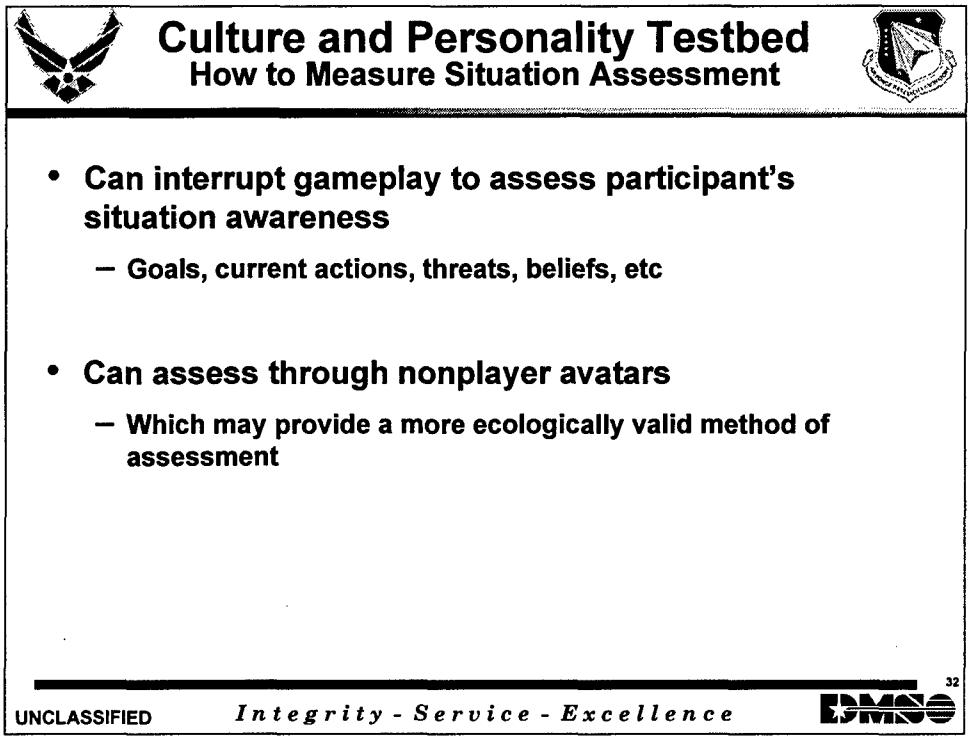

Situation assessment can be measured by

Can interrupt gameplay to assess participant's situation awareness

Goals, current actions, threats, beliefs, etc

Can assess through nonplayer avatars

Which may provide a more ecologically valid method of assessment

Culture and Personality Testbed
Initial Use of Testbed

NATO Sponsors

- Supreme Allied Command Transformation Headquarters (HQ SACT): Concept Development & Experimentation (CD&E) project " *Leader and Team Adaptability in Multinational Coalitions: Cultural Diversity in Cognition and Teamwork"*
- Research and Technology Organization (RTO) Human Factors & Medicine Exploratory Team 49 (HFM ET-049) project *"Adaptability in Coalition Teamwork"*

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International Research Team

- FOCUS: Improving team adaptability in multi-cultural military staff environments
- EFFORT:
  - Establish national & NATO testbeds
  - Identify system design requirements for collaborative tools, decision aids, & training
  - Develop methods for experimentation
  - Develop conceptual model of cultural adaptability for military operations

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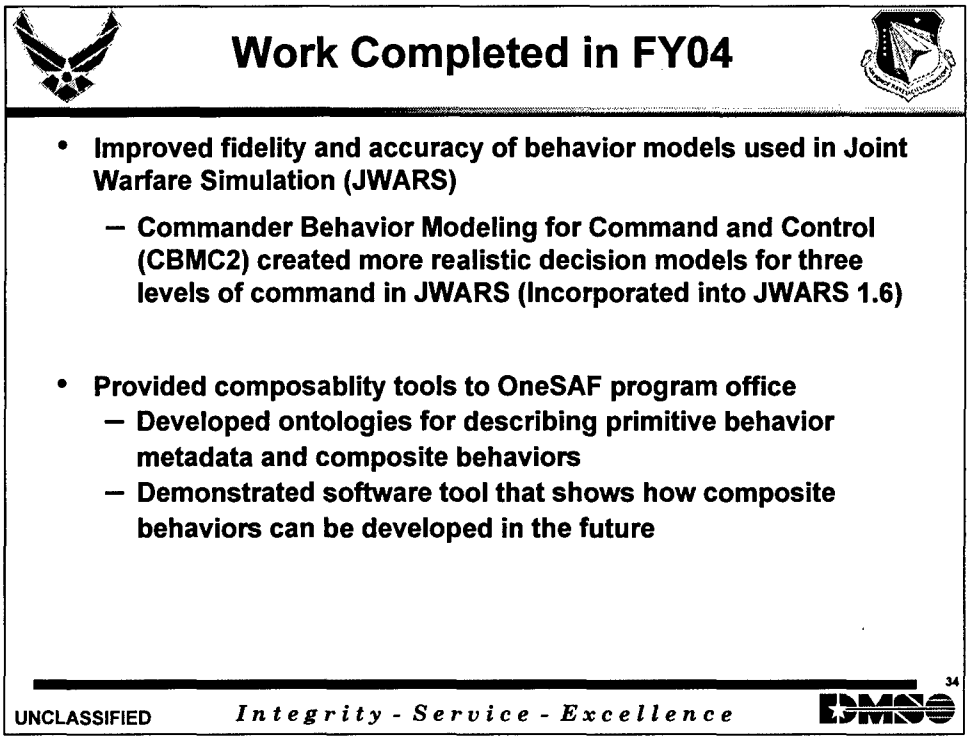
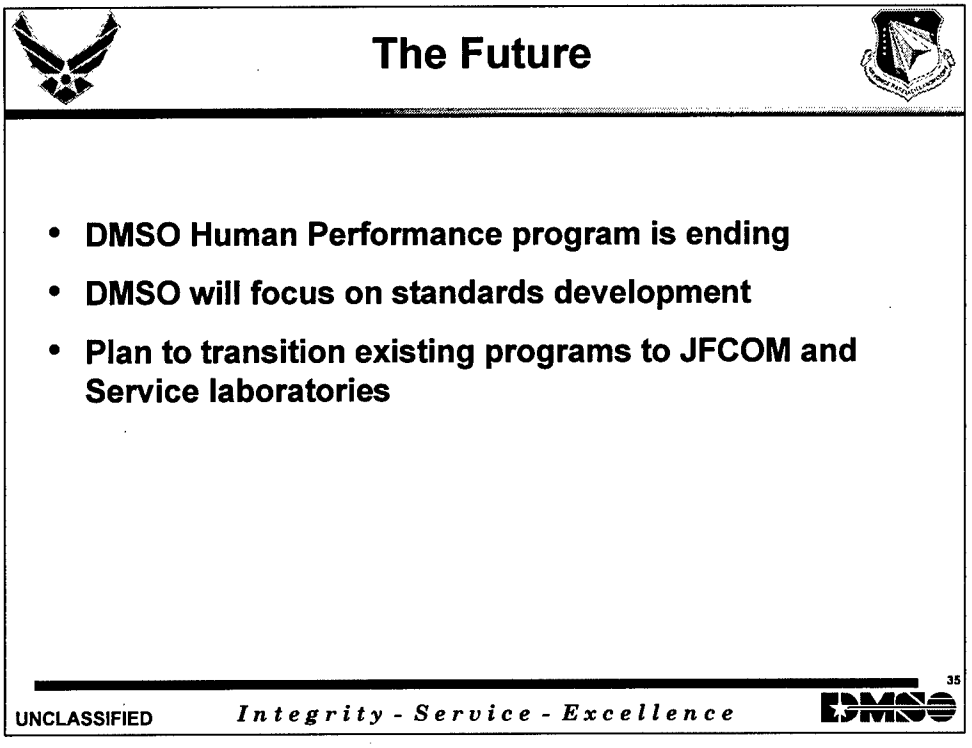
Sponsors include:



In FY04 we

Improved fidelity and accuracy of behavior models used in Joint Warfare Simulation (JWARS)

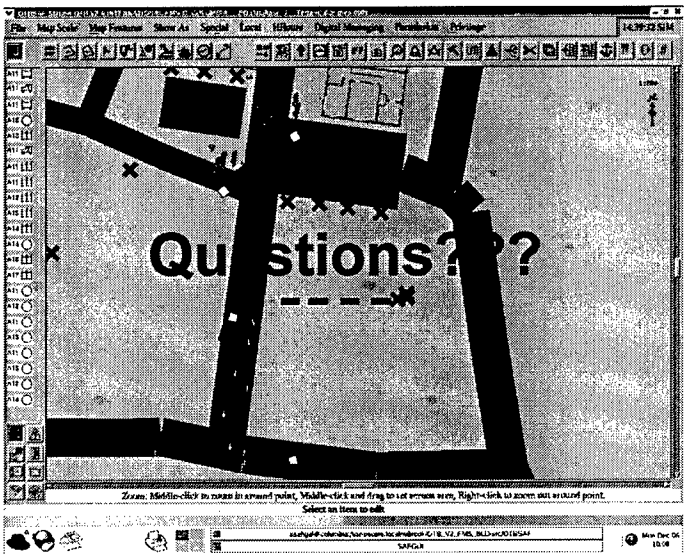
Commander Behavior Modeling for Command and Control (CBMC2) created more realistic decision models for three levels of command in JWARS (Incorporated into JWARS 1.6)



DMSO Human Performance program is ending

DMSO will focus on standards development

Plan to transition existing programs to JFCOM and Service laboratories



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